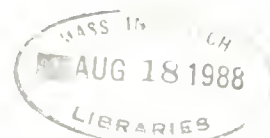






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RATIONING IN CENTRALLY PLANNED ECONOMIES

Julio J. Rotemberg

Working Paper #2024-88

May 1988

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### ABSTRACT

This paper shows that, if prices for individual items (price tags) must be set before demand is known, it is rational for a planner maximizing a conventional social welfare function to induce more rationing than would exist under laissez-faire. This can rationalize the chronic rationing in both goods and labor markets observed in centrally planned economies.

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One of the principal differences between centrally planned and more market oriented economies is that rationing is endemic in the former. These shortages in goods and labor markets have been documented by a wide range of observers including Kornai (1980), Wilczynski (1982) and Walker (1986). Interestingly such shortages are also common when more market oriented economies go through periods of price controls (Rockoff (1982)). This paper attempts to explain the apparently peculiar tendency of governments to generate rationing whenever they have control over prices.

The basic premise in the paper is that prices must be set in relative ignorance; the state of demand is unknown when prices at which transactions take place are set. That this premise leads to equilibrium rationing is not surprising given that rationing is endemic in the "disequilibrium" literature which is driven by the assumption that prices are set in advance (See, for example, Barro and Grossman (1974)). What still needs to be explained is why prices chosen by central planners make rationing more common than under decentralized price setting. I show that this difference is an almost necessary consequence of assuming that the planner seeks to achieve an efficient allocation of resources. When planners and price setting firms are put on equal footing in terms of the information they have when prices are set, benign planners rationally accept more frequent rationing in return for lower prices. Before reviewing this explanation in detail, it is worth considering some of the alternative explanations for rationing in centrally planned economies.

The first set of explanations states that shortages, while bad in themselves, help the political position of bureaucratic planners. Kornai (1986) gives three arguments of this type. He states that shortages may legitimize planning "rationing, intervention taut

planning are needed because of shortage". On its face, this argument seems problematic since those with whom the government seeks legitimacy ought to realize that shortages are due to inaccurate planning. Kornai also views shortages as a stimulant: "produce more because your output is urgently demanded by the buyer". Again, some measure of irrationality seems necessary for shortages to accomplish this stimulative function better than high prices. Finally Kornai regards shortages as a "lubricant" which helps because it ensures that all output, no matter how bad is accepted. Along slightly different lines Kornai (1980,1986) has suggested that the shortages are due to the fact that firms under central planning are in a permanent "hunger" for investment. This hunger is in turn explained by the absence of penalties for unsuccessful investments. This begs the question of why planners provide such a poor set of incentives for appropriate investments as well as failing to explain why foodstuffs are relatively frequently rationed in Eastern Europe. My own assessment is that these quite interesting stories due to Kornai are incomplete, at least if one insists that all agents act rationally. They do not pinpoint the differences in objectives and opportunities which lead planners to ration more than do price setting firms.

Another possibility is that planners are simply more ignorant than are price setters under laissez-faire. As a result prices may be better tailored to demand under the latter regime. Under planning, by contrast, prices may often be either too high (resulting in excessive inventory accumulation) or too low (resulting in shortages). This explanation has two shortcomings. First, shortages seem to be much more common in Eastern Europe than are situations of excess supply. This, however, may simply mean that the social losses from accumulating excessive inventories are higher than the social losses from distributing goods via rationing. Second, and more importantly,

it fails to explain why the central planners do not assign pricing decisions to those whose information is commensurate with that of price setters under laissez-faire. Stated differently, it fails to explain why an institution which apparently wastes information is adopted.

A third explanation is that planners prefer lower prices than those of laissez-faire for distributional reasons. This could lead to rationing even if prices do not have to set before demand is realized. Weitzman (1977) presents an argument along these lines. He considers a benign government who wishes to distribute a given stock of a commodity. He suggests that giving away an equal amount of the commodity to each family (i.e. charging a price essentially equal to zero and rationing) is strictly superior to selling the stock at a market clearing price when the "need" for the commodity is sufficiently unrelated to income. There are several difficulties with this distributional argument for low prices. First, if there is a resale market, individuals with relatively low willingness to pay for the commodity will sell it to those with high willingness to pay. The result of the low price policy is then a redistribution of income which can be achieved more easily by giving away money to exactly those who qualified for the cheap units of the commodity. The absence of a resale market generally only means that individuals strictly prefer the money transfer to the redistribution via cheap commodities. So, what is needed to rationalize zero prices with rationing is that the government care directly about the distribution of goods across individuals. While this may be plausible for some goods it is hard to believe it applies to the myriad goods (including goods and services bought by firms) for which there are shortages in Eastern Europe.

A fourth explanation is that monopoly elements are inevitable under laissez-faire and this leads to prices which are generally too



high. With prices this high, firms find it optimal to ration only rarely even if price is set before demand is known. By contrast, a planner seeking efficiency might prefer lower prices and more frequent rationing. This explanation for extra rationing under planning requires that prices be set before demand is known. Otherwise, a superior outcome could be obtained by setting prices at their market clearing level as in Lange (1936,1937). This paper shows that, whatever its merits, this monopoly based argument is actually unnecessary to explain increased rationing under central planning. If prices must be set before demand is known, a benign planner chooses more rationing than would materialize even under perfect competition.

The setting I consider has capacity choice as well as pricing decisions taking place before demand is known. Under decentralized pricing, the model is an extension of Prescott (1975).<sup>1</sup> Just as in Prescott (1975) I assume a very simple cost structure with constant long run marginal cost. I depart from Prescott (1975) in modelling the demand side. He assumes all consumers share the same reservation price for all the units that they purchase and that this reservation price is independent of the state of demand; only the number of units for which consumers are willing to pay this reservation price is stochastic. By contrast I allow demand in each state of nature to be a general decreasing function of price with more being demanded at each price when there is a high realization of demand. This slight generalization of Prescott (1975) has profound consequences on the welfare aspects of decentralized price setting. Prescott (1975) shows that, for his specification of demand, competition with rigid prices leads to a first best allocation of resources. I show that any departure from the demand functions assumed by Prescott makes the competitive outcome suboptimal.

This suboptimality has two aspects. First, for low states of

demand, efficiency dictates that prices be independent of capacity costs and that they equal short run marginal cost. By contrast, firms with rigid prices will charge prices that cover their capacity costs even in low states of demand. A firm would never be willing to post a price which does not cover its capacity costs for its low price would ensure that it always made sales and always lost money. These high prices in low states lead to purchased quantities which are inefficiently low (except in the Prescott case where the demand curves are vertical at the prices charged in equilibrium). The second inefficiency arises because prices are too low when demand is high. Firms cannot charge very high prices; they are unable to make sales at these prices because even customers with high willingness to pay are able to buy units from firms with low prices. The willingness to pay for additional capacity is thus not reflected in the private incentives to invest and, as a result, capacity is too low. In the Prescott case this inefficiency is absent because demand becomes horizontal at the reservation price so that consumers are in fact not willing to pay more for extra capacity.

These two inefficiencies call for the government to intervene in two ways. First, and this type of government intervention is quite common, small subsidies which raises capacity are always worthwhile. Second, reductions in prices, even when accompanied by increased rationing are worthwhile because they raise sales when demand is low. A decentralized economy would find it difficult to achieve these price reductions because their benefits are spread over all consumers.

In Section II, I focus on the partial equilibrium of a particular goods market. I contrast the efficient outcome with flexible prices to the inefficient decentralized outcome under pre-set prices and also to the planning outcome. I show that, if the apportionment of cheap units to customers is itself efficient as in

Levitan and Shubik (1972) and Kreps and Scheinkman (1983), planning achieves the first best outcome. Moreover, this outcome tends to be achieved with more rationing than under decentralized pricing. The assumption of efficient apportionment ensures that this rationing does not, by itself, generate any inefficiencies. Thus I am showing that in an environment where rationing is not intrinsically costly it is worth using this allocation mechanism. One suspects that there exist also more general environments where rationing has some social costs (in that individuals spend resources obtaining the rationed good or in that individuals with relatively low willingness to pay consume the scarce good) and where the benefits of rationing described here outweigh the costs. One example of such an environment is presented at the end of the section.

In Section III, I briefly sketch how the model applies to a labor market where workers must choose their wage before knowing labor demand. I show that here too, planning optimally induces the sort of excess demand in labor market which appears present in centrally planned economies (Kornai (1980), Wilczynski (1982)). In addition, I use this labor market model to show that aggregate output will fluctuate less under planning.

Throughout Sections II and III, centralized price setters are able to achieve better outcomes than decentralized price setters. Since economies with decentralized price setting appear so successful and since even many centrally planned economies seem intent on moving to greater decentralization (viz. perestroika in the Soviet Union) I comment in Section IV on some of the costs of centralized price setting. The choice between centralization and decentralization then becomes a choice between these other costs and the benefits I describe at length in this paper. Section V concludes.



## II Goods Market

I consider an industry producing a nonstorable good in which capacity must be chosen relatively early. The building of capacity sufficient to produce one unit of output involves  $v$  units of labor. Letting  $Y$  denote the amount of capacity that is built, output  $Q$  cannot later exceed  $Y$ . Demand, which is perceived initially as random, is eventually realized. This leads to a volume of purchases  $Q$ . In order to be able to meet these purchases an additional  $cQ$  units of "variable" labor must also be hired. In other words, the cost in units of labor of producing output  $Q$  is:

$$C(Q) = cQ + vY \quad Q \leq Y \quad (1)$$

The assumption that output cannot exceed installed capacity is obviously extreme. All that is necessary for this analysis is that marginal cost jump discontinuously when firms reach a certain level of output. This might occur when it is necessary to add a second or third shift of workers.

The quantity demanded in state  $s$  when a uniform price  $P$  is charged for all units is given by  $D(P,s)$  where  $D$  is strictly increasing in  $s$  and weakly decreasing in  $P$ . Without loss of generality  $s$  can be taken to be uniform between zero and one. The random state of demand can represent a sectoral shift in preferences or an aggregate shift in demand which can in turn be due to a change either in government spending or in productivity elsewhere in the economy.

### i) Benchmark: Flexible Prices

The standard competitive equilibrium for this industry is computed assuming that the walrasian auctioneer knows  $s$ . He picks a

price such that the market clears for each  $s$ . This equilibrium is shown in Figure 1. For sufficiently low realizations of demand the ex post price equals marginal cost  $c$ . For realizations of demand such that more than  $Y$  is demanded at a price of  $c$ , the price ensures that capacity  $Y$  is demanded. With risk neutrality, firms break even on average and capacity  $Y$  is such that:

$$\int (P - c) s ds = v$$

where  $P$  is the minimum of  $c$  and the price which equates  $D(P, s)$  to  $Y$ .

## ii) Competition with Price Tags

Firms pick their price tags after they choose capacity. A price tag is an offer to sell a specified unit at a given price. Then demand is realized as customers shop amongst the items with tags.<sup>2</sup> Search is free so that customers always buy the cheap items first. Only after demand is realized is  $Q$  actually produced at an additional marginal cost of  $c$ . The assumption that all prices are chosen ab initio without any information on the sales that have taken place at other prices may seem a little unintuitive given that cheap units are sold first. As I show below this assumption is made mainly for convenience and can be dispensed with at no cost.

Since prices of different firms differ in equilibrium, the analysis depends on which customers end up with the cheap items. The simplest assumption is that this apportionment is efficient so the cheap units go to those who value them the most. In other words, if  $x$  units are sold at the lowest price, the demand faced by firms which charge the next highest price  $P$  is  $D(P, s) - x$ . This rule is employed by Levitan and Shubik (1972) and Kreps and Scheinkman (1983). It is appropriate if there is a resale market,<sup>3</sup> if customers who value the units most rush to buy them so that they obtain them at the lowest

price and if all customers are identical and the cheap units are divided evenly among customers.

A competitive equilibrium in this market is a set of capacity choices and prices such that there is no incentive to change either capacity or price. This equilibrium is easiest to picture if one imagines a continuum of firms buying a small amount of capacity each and expecting to charge different prices. To prevent deviations at the stage in which capacity is chosen, firms must expect to break even no matter what price they expect to charge. As a corollary, firms must make the same profits no matter what price they choose.

To describe the equilibrium I define an equilibrium "supply function"  $B(P)$  which gives the units of output whose posted price is smaller than or equal to  $P$ . The "marginal price in state  $s$ " can then be defined as the price  $P(s)$  such that:

$$B(P(s)) = D(P(s), s) \quad (2)$$

Firms who charge  $P(\sigma)$  only make sales when  $s$  is greater than or equal to  $\sigma$ . When the state is lower than  $\sigma$ , there is sufficient capacity installed by firms charging lower prices that those charging  $P(\sigma)$  do not make sales. Therefore, the expected profits of a firm charging  $P(s)$  can be written as:

$$(1 - s)(P(s) - c) - v \quad (3)$$

In equilibrium, a firm charging a given price  $P$  must break even. This means that there must exist a state  $\sigma$  for which this price equals  $P(\sigma)$  and the expression in (3) is equal to zero for that state. The lowest price charged must make (3) zero for  $s$  equal to zero since the firm which charges the lowest price always sells. Therefore the lowest price equals  $c+v$ . Setting (3) to zero gives prices which increase very fast in  $s$ , particularly as  $s$  approaches one since:

$$\begin{aligned} P(s) &= c + v/(1-s) \\ dP(s)/ds &= v/(1-s)^2 \end{aligned} \quad (4)$$

The reason prices must increase fast, particularly as  $s$  becomes big is that firms are now selling only rarely and thus need to charge very high prices to recoup their fixed costs. While (3) is zero for all prices charged, it is not true that all prices which equate (3) to zero will actually be charged. I now show that there exists an  $s$  strictly below one such that prices above  $P(s)$  are not charged. Moreover there could be many other prices which are not charged.

Consider the change in quantity demanded as  $s$  changes while  $P$  varies according to (4):

$$dD/ds = D_1(dP(s)/ds) + D_2 \quad (5)$$

where subscripts denote partial derivatives. Assuming that  $D_1$  is bounded and different from zero while  $D_2$  is also bounded, this expression must be negative as  $s$  approaches one since  $dP(s)/ds$  becomes unbounded. Then, for a sufficiently high state  $\sigma$  there exists no state such that the total change in quantity demanded from  $\sigma$  to higher states is positive when prices respond as in (4). This means that, if  $P(\sigma)$  is charged in equilibrium, no higher price is charged. If  $P(\sigma)$  is not charged in equilibrium there may be some higher state,  $\sigma'$ , such that  $P(\sigma')$  is charged in equilibrium. However, this  $\sigma'$  must be strictly below one as long as demand at an infinite price is zero. Moreover, by the earlier argument, no price above  $P(\sigma')$  is charged in equilibrium. The highest price charged in equilibrium will be labelled  $P(s^*)$ .

On a related vein, there is no need for all prices between  $c+v$  and  $P(s^*)$  to be charged in equilibrium. Indeed, if a given price  $P(\sigma)$  is charged, slightly higher prices will only be charged if the demand curve is sufficiently inelastic, i.e. if when prices respond according to (4) quantity demanded increases. From (4) this requires that  $D_2 > -D_1 v / (1-s)^2$ .

Recapitulating, the equilibrium features:

$$\begin{aligned}
 P(s) &= c + v/(1-s) && \text{For at least some } s \in [0, s^*]^4 \\
 Y &= D(P(s^*), s^*) && (6)
 \end{aligned}$$

This is an equilibrium because deviations are not profitable at either the pricing or the capacity building stage. Consider the pricing stage. Charging a price lower than  $c+v$  is unattractive since firms charging  $c+v$  are always able to sell their output. Since the firms are infinitesimal they can ignore the effect on the sales of higher priced firms of stopping their supply at any given price. Therefore they are indifferent to the prices actually charged between  $c+v$  and  $P(s^*)$ . The prices not charged lead to losses. Raising the price beyond  $P(s^*)$  also leads to losses since  $P(s^*)$  is the highest price at which firms break even. At the capacity building stage the firms building capacity are breaking even. Thus there is no incentive for either entry or exit.

The equilibrium given by (6) is depicted in figure 2. Sufficient capacity is installed to meet the lowest state of demand at a price of  $c+v$ . When  $dD/ds$  evaluated at zero is positive, price gradually rises to  $P(s^*)$ , otherwise, prices slightly above  $c+v$  are not charged though even higher prices may well be charged. Total capacity equals that which is necessary to meet the demand in state  $s^*$  at price  $P(s^*)$ .

The equilibrium exhibits a rather strong form of rationing. Unless, as in Prescott's original model demand is horizontal at  $P(s^*)$ , there are states of nature (those above  $s^*$ ) in which individuals are willing to pay more than is charged by any firm and yet are unable to purchase the good.<sup>5</sup> In other words, no one is charging a price that keeps individuals indifferent between buying and not buying. Obviously there is also a weaker form of rationing in equilibrium in that not all individuals are able to purchase at the very lowest price.<sup>6</sup>



This equilibrium leads to sales which are inefficient in two important respects. These inefficiencies may be surprising since the main point of Prescott's original model was that sales were optimal even though prices are rigid. As I show below, his efficiency result is valid only for his very special form of demand. The first inefficiency is that in the case where  $s^*$  is positive the quantity supplied in the states below  $s^*$  is too low. In these states, not all capacity is utilized whereas the prices exceed  $c+v$ . As long as the demand curves are nonvertical at these prices, the prices also represent the marginal social value of increasing supply by one unit. On the other hand, the social marginal cost of producing additional units is only  $c$ . It is only in the case where as in Prescott (1975) demand curves are vertical at the quantities supplied when the state is below  $s^*$  that the social marginal benefit of one unit can be considerably less than  $c$  even though price exceeds  $c+v$ .

This inefficiency can be described as follows. The rigidity of prices forces firms to charge some of their capacity costs even when demand is low. This relatively high price generally leads consumers to inefficiently curtail their consumptions.<sup>7</sup>

The second inefficiency is that  $s^*$  itself is inefficiently low even if one accepts that prices must remain rigid. Stated differently, a subsidy to capacity is generally optimal even if pricing proceeds as before. The private benefits to a firm from building one additional unit of capacity and charging any price between  $c+v$  and  $P(s^*)$  is  $(1-s^*)(P(s^*)-c)$  which equals  $v$ . Now consider the social benefits from increasing capacity by one unit and charging, say,  $P(s^*)$ . These units will only be sold if the state exceeds  $s^*$ . Since the allotment of this unit will be efficient the marginal social value of this unit in state  $s$ ,  $m(s)$  is given by the equation:

$$D(m(s), s) = Y. \quad (7)$$

Differentiating this equation for states above  $s^*$ :

$$D_1 dm + D_2 ds = 0$$

so that  $m$  never falls and must rise unless  $D_1$  is zero, i.e. unless the demand curve is horizontal. The total social value from building this unit of capacity can now be written as:

$$\int_{s^*}^1 [m(s) - c] ds \quad (8)$$

Comparing (8) to the private benefits it is apparent that the social benefits are larger if  $m(s)$ , which equals  $P(s^*)$  at  $s^*$ , is ever bigger than  $P(s^*)$  for higher values of  $s$ . Therefore the social benefits are larger unless the demand curve is horizontal at  $P(s^*)$  for all states above  $s^*$ . The basic reason for this inefficiency is that firms do not capture the full social value of their capacity when they are rationing individuals in the strong sense described above. They thus have insufficient incentive to invest.

In conclusion the efficiency result of Prescott (1975) hinges on two properties of his demand curves. He assumes that, independent of  $s$ , all individuals have the same reservation price  $r$  for all units that they purchase. Only the quantity  $D$  they are willing to buy at  $r$  varies with  $s$ . Efficiency obtains in my model only when demand at prices below  $P(s^*)$  is vertical (which is true under Prescott's assumptions because demand is independent of price for prices below  $r$ ) and when demand is horizontal at  $P(s^*)$  (which obtains in Prescott's case because  $P(s^*)$  equals  $r$ ). More generally there is underproduction both in that too little is supplied for states below  $s^*$  and that capacity is too low.

One method of increasing capacity is to reduce the private capacity costs  $v$ . From (6) this lowers prices and therefore raises output and capacity. It is of some interest (in part because it serves to compare laissez-faire to planning) to show that this

intervention need not have any particular effect on the frequency of rationing. To show this I construct two examples, one in which rationing increases and the other in which it does not. In both examples marginal cost  $c$  is zero, and demand  $D(P,s)$  can be written as  $g(s)H(P)$  with  $g_1(s)/g(s)$  equal to a constant. This means that rationing occurs for states higher than  $s^*$ :

$$H_1v/[H(1-s^*)^2] - g_1/g = 0$$

where  $H_1v/H$  must exceed  $g_1/g$  for  $s^*$  to be positive. In the first case  $H_1$  is constant so demand is linear. Then, it is apparent from this expression that an increase in  $v$  (which corresponds to less capacity) is matched by a fall in  $s^*$  (which corresponds to an increase in the frequency of rationing).

In the second example the function  $H$  has constant elasticity. Using (6) for the level of prices this means that  $H_1v/[(1-s)H]$  is constant. Using the earlier expression it is apparent that  $s^*$ , the frequency of rationing, is independent of  $v$ . The reason the effect of an increase in  $v$  has an ambiguous effect on rationing is that, while it does reduce capacity, it also raises prices.

Before closing this section it is worthwhile to show that the model is robust to changing the assumption that all prices, including high prices, are set in concrete before anything is known about demand. In particular, it is possible to think of demand as a flow of potential customers. More demand is then a longer flow; the state  $s$  is an indicator of the length of time for which the flow is maintained. To be consistent with efficient allotment of cheap units the first customers to arrive must always be the ones with the highest reservation price (and this reservation price must be unobservable to firms). Firms are now free to change prices as customers flow into the market. Certain firms will charge a low price initially and make sales. We can label this price  $P(0)$  and, in equilibrium it must cover



total cost  $c+v$ . Until a total of  $D(c+v,0)$  customers arrive there is no information about the state of demand. Continued arrival of customers beyond this point signifies that the state is higher than it could have been. If demand reaches state  $s$  (so that the flow remains uninterrupted at  $s$ ) the lowest price charged is  $P(s)$ . Once again, firms must be indifferent between charging a price  $P(s)$  in state  $s$  and waiting to charge a different price if demand continues unabated and demand reaches the state  $\sigma$ . This means that

$$P(s)-c = \text{Prob}[\text{state} > \sigma \mid \text{state} \geq s][P(\sigma)-c]. \quad (9)$$

The probability in this expression is, for  $s$  uniform, simply  $(1-\sigma)/(1-s)$ . Therefore, using the fact that  $P(0)$  equals  $c+v$ :

$$(1-\sigma)[P(\sigma)-c] = v$$

as before. The distribution of prices is the same when firms are free to change their prices as they discover that the cheap units have been sold.

### iii) Central Planning

In this section I delegate capacity and pricing decisions to a central planner who also has the power of levying lump-sum taxes. Central planners thus have two abilities denied to firms under decentralized price setting. First, they need not break even in this market. In effect I have allowed those who govern price setting firms to break this budget constraint as well since I have considered subsidizing capacity. Second, planners can coordinate pricing so prices serve not only the interest of firms but also those of consumers.

The main constraint on the planner is that he must also pick prices before demand is realized. I continue to assume that the whenever demand exceeds supply at a given price, the apportionment of

the cheap units efficient. The planner chooses the number of units whose price is smaller than or equal to  $P$ ,  $B(P)$ . Equivalently, the planner can be thought of as picking a set of prices  $P(s)$  defined by (2). Let  $s^*$  be the smallest state such that  $D(P(s^*), s^*)$  equals  $Y$ . Then,  $P(s^*)$  is the highest price actually charged since no further units are sold. For lower states,  $P(s)$  is again the marginal price in that customers purchase  $D(P(s), s)$ . I define  $m(s, Q)$  as in (7) as the marginal willingness to pay for another unit when  $Q$  units are being given to those who value them the most. Thus:

$$D(m(s, Q), s) = Q \quad (10)$$

The planner maximizes conventional social welfare which is given by the integral of the private willingness to pay for the goods sold minus their cost of production. Thus he maximizes  $F$ :

$$F = \int_0^{s^*} \int_0^{D(P(s), s)} [m(s, Q) - c] s dQ ds + \int_{s^*}^1 \int_0^Y [m(s, Q) - c] s dQ ds - vY \quad (11)$$

At an optimum:

$$dF/dP(s) = \{m[s, D(P(s), s)] - c\} D_1 = [P(s) - c] D_1 = 0 \quad s < s^* \quad (12)$$

where the second equality is obtained from (10). Equation (12) requires that, as long as the demand curve is nonvertical (so that prices matter) price in all states in which more is available for sale be set to marginal cost  $c$ . This is the same price as prevails under flexible prices with competition. It ensures that there is no inefficiently idle capacity when demand is low. The difference between planning and decentralized flexible prices is that here the price remains  $c$  even when demand is very high.

Similarly:

$$dF/dY = \int_{s^*}^1 [m(s, Y) - c] s ds - v = 0 \quad (13)$$

Since  $m(s, Y)$  is the market clearing price under flexible prices when capacity is  $Y$  and since the market clearing price is  $c$  for states below  $s^*$ , (13) is equivalent to (1), the equation giving capacity in

the equilibrium with flexible prices. Since the allocation under planning with rigid prices is the same as the efficient allocation under competition with flexible prices, planning achieves the first best even with price rigidity.<sup>8</sup> The ability to reach the first best depends obviously on the use of efficient apportionment. There would otherwise exist distortions in consumption.

I now study the effect of changes in  $v$  on equilibrium rationing. Once again, it is apparent from (13) that increases in  $v$  lead to reduced capacity. The main difference with the case of decentralized price setting is that these reductions in capacity would not normally alter the prices that are charged. In particular, small reductions in capacity would not affect the fact that  $D(c,0)$  is below capacity. Therefore the optimal price remains  $c$  and the number of states in which there is rationing unambiguously increases. This is contrast to the case of decentralized price setting where the response of rationing was ambiguous.

An increase in  $v$  can come about for a variety of reasons. One important determinant of  $v$  is the social priority granted to the good in question. In particular, if the government wishes to expand the provision of public goods such as defense, the social cost of the resources needed for expansion of industries producing private goods becomes high and this is reflected in a high  $v$ . Thus the model can explain why rationing in Eastern Europe has become less widespread as consumer goods have been given a higher social priority.<sup>9</sup> Similarly it can explain why, in planned economies, goods whose supply suddenly falls become more likely to be rationed.

#### iv) Comparison of the Extent of Rationing

The focus of this study is whether planning leads to more

rationing than laissez-faire. There are two ways of carrying out this comparison. The first is to assume that  $c$  and  $v$  are the same in both regimes and that the planner chooses capacity optimally while decentralized price setters choose capacity as in (6). While this comparison may seem natural it fails to incorporate the subsidy to capacity that governments in countries with decentralized price setting would find socially beneficial. After all, a benign government who faces decentralized rigid prices would tend to artificially reduce  $v$  to obtain a more desirable outcome. One crude way of incorporating this effect is to compare the extent of rationing under the assumption that the  $v$ 's are chosen in such a manner that capacity is the same in both regimes. I first carry out this comparison assuming, for simplicity, that  $c$  is the same in both regimes.

As long as capacity is sufficiently large that it exceeds  $D(c,0)$  the central planner will choose a price of  $c$ . For capacity to be finite under decentralized price setting, the subsidized cost of capacity  $v$  will have to be strictly positive. This means that the lowest price under decentralized price setting  $c+v$  exceeds the price under central planning and this is even more true of prices in higher states. Therefore, demand is less under decentralized price setting and the extent of rationing is unambiguously lower as well.

The results are more ambiguous if it is assumed instead that  $c$  and  $v$  are the same under both regimes. While laissez-faire has higher prices which leads to less rationing, capacity is larger under planning since capacity is too low when prices are decentralized. This second effect can make rationing more prevalent under laissez-faire. While I do not have general results I present some examples. The first two examples have more rationing under planning. The last example, which is somewhat more artificial has more rationing under

decentralized price setting.

The first special case has a maximum reservation price of  $r$  so demand curves become horizontal at this price. The demand curves are also assumed to be sufficiently inelastic so that, under decentralized price setting  $P(s)$  is a continuous function which reaches the maximum value of  $r$  in some state  $s^*$ . There is now no rationing in the strong form since no one wants to pay more than  $r$ . Under flexible prices, on the other hand the price in state 1 must exceed  $c$ , generally by a substantial margin, since fixed costs are only covered in the states where  $Y$  is demanded. This means that, under central planning with rigid prices, where capacity is also  $Y$  but price always equals  $c$  there must be a set of states with positive measure in which individuals willing to pay more than  $c$  are rationed.

The second special case has two states, high ( $h$ ) and low ( $l$ ) which occur with probability  $\mu$  and  $(1-\mu)$  respectively. Demand in these states can be written as  $D_h(P)$  and  $D_l(P)$ . I now demonstrate that rationing under central planning occurs whenever there is rationing with decentralized price setting. Moreover there are many configurations of demand such that rationing sometimes occurs in the former but not in the latter.

With flexible prices the prices in the two states will differ. There are two possible configurations of demand. If  $D_h(c+v/\mu)$  exceeds  $D_l(c)$  the equilibrium prices in the high and low states are  $c+v/\mu$  and  $c$  respectively with strictly more being sold in the high state. In this case the capacity constraint is binding only in the high state so all capacity costs must be recouped in the high state. Alternatively, if  $D_h(c+v/\mu)$  is lower than  $D_l(c)$ , then the price in the low state is higher than  $c$  and sales are the same in the two states. Here the capacity constraint is binding in both states. Letting the price in  $l$  be  $z$ , the price in the high state is now  $c+[v-(1-\mu)(z-c)]/\mu$ . Under



central planning, the allocations is the same as with flexible prices. When  $D_h(c+v/\mu)$  exceeds  $D_l(c)$  rationing can be avoided by charging  $c$  for  $D_l(c)$  units and charging  $c+v/\mu$  for the rest (which equal  $D_h(c+v/\mu) - D_l(c)$ ).

With decentralized price setting firms will offer  $D_l(c+v)$  units at a price of  $c+v$ . The market thus clears at this price in state 1. In addition firms would be willing to offer some units at a price of  $c+v/\mu$  which might be sold in the high state. What is important about this price is that, since it must cover fixed costs through sales in the high state only, it is identical to the high price charged under flexible prices when capacity is binding only in the high state. If  $D_h(c+v/\mu)$  exceeds  $D_l(c+v)$  customers would buy some of these units and they will be offered. In this case there is no rationing. On the other hand, customers in the high state will be rationed if  $D_h(c+v/\mu)$  is lower than  $D_l(c+v)$  for in this case no additional units would be bought at a price of  $c+v/\mu$ .

In summary rationing occurs with decentralized price setting when  $D_l(c+v)$  exceeds  $D_h(c+v/\mu)$  while it occurs under central planning if  $D_l(c)$  exceeds  $D_h(c+v/\mu)$ . Since  $D_l(c)$  is bigger than  $D_l(c+v)$ , rationing in the high state occurs in centrally planned economies under a strictly larger set of configurations of demand. This result obtains because rationing occurs whenever charging  $c+v/\mu$  does not bring forth more sales in the high state. This particular high price is much more likely to increase sales in the high state under decentralization since decentralized pricing has relatively high prices in the low state.

A corollary of the results for the two state example is that, with any finite number  $S$  of states, if there is rationing in the highest state under laissez-faire then there is also rationing in this state under planning. The reason is the following. The presence of

rationing in state  $S$  under laissez-faire means that  $D(c+v/\mu, S)$  where  $\mu$  is now the probability of the highest state is lower than  $D(P(s^*), s^*)$  where  $s^*$  is the highest state without rationing. However:

$$D(P(s^*), s^*) < D(c, s^*) \leq D(c, S-1)$$

where the first inequality follows from the fact that  $c$  is below  $P(s^*)$ . Since there is rationing in the highest state under laissez-faire  $s^*$  is smaller than  $S$  and the second inequality follows. This establishes that  $D(c+v/\mu, S)$  is smaller than  $D(c, S-1)$  and this is the condition under which it is not socially worthwhile to build capacity exclusively for use in the highest state. As we saw above this implies that there is rationing in the highest state.

The third special case is constructed to show that the result that rationing is more prevalent under central planning is not completely general. It is illustrated in Figure 3. There are three states 1, 2 and 3. In state 1 demand is vertical for prices between  $c+v$  and  $c$  and is horizontal at  $c+v$ . This has the important effect of eliminating the difference (which drove the previous example) between sales under the two regimes in the lowest state. The demand curves for the other two states have sufficiently low probability that the prices at which firms would be willing to make sales in these states [ $P(2)$  and  $P(3)$ ] are quite high. As a result,  $D(P(2), 2)$  and  $D(P(3), 3)$  are both slightly lower than  $D(c+v, 1)$ . Therefore there is rationing under laissez-faire in both states 2 and 3.

A central planner will also ration customers in these two states if he chooses to install capacity equal to  $D(c, 1)$  for he would not be willing to charge more than  $c+v$  for these units (since state 1 sales would otherwise disappear). If, instead, additional capacity were installed these additional units could be priced so the market clears in state 2. Central planning is therefore capable of less rationing if more capacity than  $D(c, 1)$  is installed i.e. if more than

$D(c,1)$  were installed by an industry with flexible prices. By installing one more unit, a firm with flexible prices would receive almost  $P(2)$  in state 2 and almost  $P(3)$  in state 3. Since the price  $P(2)$  in both states is almost enough to cover fixed costs, receiving  $P(3)$  instead of  $P(2)$  with positive probability is enough to make this additional capacity investment worthwhile. This argument shows that the tendency of laissez-faire to restrict capacity can also lead to additional rationing.

The argument also shows that the government would find it worthwhile to subsidize capacity even under laissez-faire; the social benefit from inducing a firm to build some capacity and charge  $P(2)$  equals  $P(3)$  with some probability. With this additional capacity there would be no rationing in state 2. Therefore, in this example, there is no additional rationing under laissez-faire once optimal capacity subsidies are taken into account.

#### v) An Example with Partially Random Apportionment

In this subsection I provide an example in which the apportionment of cheap units to customers is somewhat different. Rationing remains more common under central planning even though, now, planners are unable to reproduce the first best outcome.

Again, there are two states  $h$  and  $l$ . The lowest price  $P_1$  ensures that the market clears in the low state.  $D_1(P_1)$  units are sold at this price even in the high state. With efficient apportionment the high state demand for additional units at price  $P$ ,  $D'(P, P_1)$  is given by  $D_h(P) - D_1(P_1)$ .  $D'$  is depicted in Figure 4, it is obtained by a leftwards shift of  $D_h(P)$  by an amount equal to  $D_1(P_1)$ .

Suppose that, instead, a fraction  $\theta$  of  $D_h(P) - D_1(P_1)$  is distributed to those with the highest willingness to pay while the



rest is distributed randomly to those willing to pay more than  $P_1$ . The rule is a combination of efficient apportionment and of the purely random apportionment assumed by Beckman (1965). It captures the idea that those with the highest willingness to pay are more likely to get the good (and that, for a given individual the first units he gets are those for which he is willing to pay the most) without assuming complete efficiency. This partially random apportionment rule leads to the residual demand curve  $D''(P, P_1)$  in figure 4.  $D''$  is obtained by a smaller horizontal shift  $D_h$  which is accompanied by a rotation so  $D'(P_1, P_1)$  and  $D''(P_1, P_1)$  are equal.

There is rationing in the high state under laissez-faire if  $D''(c+v/\mu, c+v)$  is nonpositive. Since the horizontal shift in  $D_h$  which leads to  $D''$  is smaller than that which leads to  $D'$ , rationing is less likely under this alternative rule. In particular, there is no rationing when  $\theta$  is zero since, in this case, there is no horizontal shift in demand. I consider a configuration of  $\theta$ , demand and capacity costs such that  $D''(c+v/\mu, c+v)$  is exactly equal to zero. I now show that a planner who has installed the same capacity would always chose to ration in the high state.

The planner can consider either selling all the output at  $c+v$  or slightly reducing the sales in the low state in exchange for selling one unit a barely below  $c+v/\mu$  in the high state. By making the sale at slightly under  $c+v/\mu$  the planner would obtain a social surplus of just under  $v$ . By contrast the sale at  $c+v$  nets more than  $v$  since, on average, it is sold to somebody with a valuation much higher than  $c+v$  in the high state. Thus the planner strictly prefers to sell the last unit at  $c+v$  and ration in the high state. This argument applies with more force when  $D''(c+v/\mu, c+v)$  is negative and, more importantly, applies also when  $D''(c+v/\mu, c+v)$  is slightly positive. This means that there is a strictly richer configuration of parameters

for which planners create shortages.

### III Labor Market

It is widely asserted that the labor market exhibits excess demand in centrally planned economies. Such economies have little unemployment perhaps because the authorities frown on what they regard as idleness. On the other hand certain firms have vacancies and this leads to the impression that the labor market is quite tight.

I consider a labor market in which  $N$  workers have a reservation wage of  $\phi$ . The demand for labor in state  $s$  when there is a uniform wage  $W$  is given by  $L(W,s)$ . Since I am treating a unified market for labor, changes in  $s$  are best understood as macroeconomic in nature. They can be due to productivity changes or, again, to changes in the government's demand for goods and services. The function  $L$  is decreasing in the first argument and increasing in the second. With flexible wages the market clearing wage is the minimum of  $\phi$  and the wage which solves:

$$L(W,s) = N. \quad (14)$$

All workers are thus employed whenever the demand at the reservation wage  $L(\phi,s)$  exceeds  $N$ .

#### i) Decentralized rigid wage setting

There are at least two potentially plausible ways of introducing wage rigidity in the spirit of the Prescott model. One possibility is to let firms announce wages before the state of labor demand,  $s$ , is known. This is the assumption of Weitzman (1987) who also explicitly lets firms choose their capital intensity. The alternative is to let workers choose the wage at which they would be

willing to become employed. This second alternative, which I adopt, is reminiscent of search models in which workers choose to accept offers on the basis of a reservation wage rule.<sup>10</sup> I prefer this second formulation because the equilibrium in the Weitzman model has an empirically unappealing implication.

In the Weitzman model firms choose their wages before demand  $s$  is known but are free to pick the level of employment ex post. When demand is low firms with high wages (who also find it optimal to have large amounts of capital per worker) choose to employ few people so that workers flock to low wage firms (whose capital per worker is lower). When  $s$  is high, the high wage firms retain all the workers so that low wage firms are left with no workers and completely idle capital. This idleness of capital does not seem empirically relevant in booms.

Here I assume instead that it is the workers who must pick the wage at which they are willing to work before knowing the firms' demand for labor. As before, the demand for labor can be thought of as a flow with the cheaper workers obtaining employment first. There is again a "supply of labor"  $V(W)$  which gives the number of workers willing to work at wages lower than or equal to  $W$ . Using this function, the marginal wage in state  $s$ ,  $W(s)$ , can be defined by:

$$V(W(s)) = L(W(s), s) \quad (14)$$

Once again, a worker who charges  $W(s)$  can be sure of being hired in all states above  $s$ . Workers must be indifferent to the wage they charge. Since they earn  $\phi$  when they are not employed, any  $W(s)$  actually charged must satisfy:

$$(1-s)[W(s) - \phi] = k \quad (15)$$

where  $k$  is a positive constant. From (15) it is apparent that either the wage is  $\phi$  in all states of nature or it exceeds  $\phi$  in all states of nature. The former case applies when  $L(\phi, 1)$  is lower than  $N$  so that

wages would always equal  $\phi$  even if they were flexible. I focus instead on the more interesting case where  $L(\phi, 1)$  is bigger than  $N$ . Supposing also that  $L(\phi, 0)$  is lower than  $N$ , it follows from (15) that there is underemployment in the lowest state since the wage exceeds  $\phi$  even in this state.

Because (15) requires that wages rise very fast with  $s$  when  $s$  is high, whereas the demand for labor at an infinite wage is presumably zero, it is true once again that there exists a maximum state  $s^*$  such that no wage above  $W(s^*)$  is charged. Since workers obtain surplus equal to  $k$  from being employed, even those charging the highest wage must sometimes obtain employment. This means that:

$$L(W(s^*), s^*) = N \quad (16)$$

and firms are rationed in the amount of labor they can obtain when  $s$  exceeds  $s^*$ .

The equations (15) and (16) must be solved to obtain the distribution of wages.<sup>11</sup> The equilibrium is analogous to (6). The principal difference is that capacity  $Y$  is endogenous in the goods market while the corresponding level of possible employment  $N$  is exogenous. By contrast the price in the lowest state is independent of demand and equal to  $c+v$  while here the wage in the lowest state does depend on demand.

One appealing feature of this equilibrium is that workers are always delighted when their wage offer is accepted for they are now assured of some surplus. High wage workers are worried that, while on average they earn the same surplus as low wage workers they will receive nothing for low realizations of demand. If  $s$  is thought of again as indicating the amount of time during which firms are hiring then high wage workers are worried that  $s$  will be low and that they will remain unemployed. It is important to stress that this empirically plausible form of unemployment is quite voluntary in this

model.

## ii) Central Planning

Central planners can again eliminate the underutilization of resources by lowering prices. In the case of the labor market they will find it worthwhile to lower wages whose high level leads to underemployment in low states. The planner now chooses a supply function  $V(W)$  or, equivalently, given (14) a wage profile  $W(s)$ . Let  $s^*$  be the smallest state such that  $L(W(s^*), s^*)$  equals  $N$ . Then,  $W(s^*)$  is the highest wage actually paid. For lower states,  $W(s)$  is the marginal wage. Analogously to (10), the marginal value of an employed worker  $n(s, E)$  when  $E$  units of labor are employed is given by:

$$L(n(s, Q), s) = E \quad (17)$$

Assuming again that rationing is efficient, the planner must now maximize the integral of the marginal value of employed workers minus their reservation wage. Thus he maximizes  $F$ :

$$F = \int_0^{s^*} \int_0^{L(W(s), s)} [n(s, E) - \phi] s dE ds + \int_{s^*}^1 \int_0^N [n(s, E) - \phi] s dE ds \quad (18)$$

The choice of wages then satisfies:

$$dF/dW(s) = \{n[s, L(W(s), s)] - \phi\} L_1 = [W(s) - \phi] L_1 = 0 \quad s < s^* \quad (19)$$

where the last expression is obtained from (17). Not surprisingly, equation (12) requires that, as long as the wage matter for labor demand, the wage be set to the reservation wage whenever there is additional labor available. This means that firms are rationed in the amount of labor they can obtain whenever  $L(\phi, s)$  exceeds  $N$ .

For this particular specification of the labor market, rationing is unambiguously more prevalent under central planning than under laissez-faire. Here, capacity, which corresponds to  $N$ , is the same under decentralized pricing. Thus the only difference between



the two regimes is that wages are higher under laissez-faire. This obviously leads to less rationing.

One other contrast between the two regimes is worth drawing out. Consider the range of fluctuations in employment (that is the difference between maximum and minimum employment). This equals  $N - L(\phi, 0)$  under central planning where it equals only  $N - L(\phi + k, 0)$  under decentralized wage setting. So the model is consistent with the purportedly lower aggregate fluctuations of both employment and output in centrally planned economies.

#### IV Centralization vs. Decentralization.

This paper has taken the view that the rationing phenomena of centrally planned economies are worth explaining with a model in which governments are benign and try to improve the allocation of resources. Since many centrally planned economies are moving towards greater decentralization of price setting it seems important to discuss some of the costs of centralization which have been neglected in my discussion. One possibility I explore here is that centralization cannot provide appropriate incentives to invest when investment is, as in Grossman and Hart (1986), noncontractible. Another possibility is that the control of prices poses important administrative costs. These might be substantial since the firms' incentive to deviate is substantial. The overall choice between centralization and decentralization is then one between these other costs and the benefits described earlier.

I have shown that optimal pricing by central planners generally involves charging prices equal to ex post marginal cost  $c$ . These prices do not cover any of the costs of investment. This means that capacity investments must be separately financed by the central

authority.<sup>12</sup> This financing of capacity does not pose particular problems when the act of building capacity is contractible i.e. when it is possible for the planner to sign a contract with the firms that ensures that capacity investment takes place. It is possible to conceive of numerous investments, particularly investments in knowledge acquisition, which, while observable, are not contractible. In other words it is not possible to prove to outsiders that they have failed to take place so the firm can always demand compensation for these investments. As a result these investments will be underproduced under planning (leading perhaps to bad quality of goods). On the other hand, under decentralization, firms with superior knowledge may be able to extract rewards in the form of prices in excess of short run marginal cost.

What hurts central planning in this illustration is the inability to commit to prices in excess of marginal cost as payment for investment activities which, while observable, cannot be contracted on ex ante. These are basically the costs of horizontal (or vertical) integration considered by Grossman and Hart (1986). Unlike in their paper, central planning here has the advantage of bringing about a socially more desirable outcome conditional on the investments that have actually taken place. Governments thus confront a choice between ex post and ex ante efficiency.

Why is it that certain governments choose to centralize prices while other do not? One possibility is that governments in centrally planned economies have made a mistake by underestimating the costs of ex ante inefficiencies and that their discovery of this mistake has promoted perestroika. Another possibility is that the administrative costs of price controls are simply lower for undemocratic governments or for governments which are ideologically inclined towards centralization and that this has made centralized pricing attractive

in the past. The current move towards decentralization might then be due to a change in the desired (and feasible) product mix towards higher quality, more customized goods for which ex ante investments are more important.

## V Conclusions

This paper has presented an extremely simple model which appears to be able to explain many features of centrally planned economies including the tendency for shortages in labor and product markets. Because these shortages seem to happen at a very detailed micro level my first step has been to consider a partial equilibrium model. By contrast much of the discussion of shortages in centrally planned economies has been carried out neglecting the microeconomic detail and either postulating or estimating macroeconomic models with rigid prices.

Of particular note in this regard are Barro and Grossman (1974), Portes and Winter (1980) and Portes, Quandt, Winter and Yeo (1987). In these very aggregative models, shortages in goods markets only exist when overall consumption is short of desired overall consumption. The key insight is that such "aggregative shortages" tend to reduce labor supply so that there is inefficiently low aggregate output. Portes and Winter (1974) and Portes, Quandt, Winter and Yeo (1987) estimate structural models in which consumption demand is given by an old fashioned Keynesian consumption function while consumption supply depends on a variety of variables including, for instance, changes in investment which are treated as exogenous. The central finding of these papers is that overall consumption demand is sometimes but by no means always above supply; aggregative shortages are not chronic.



Leaving aside technical issues<sup>13</sup>, I suspect that the absence of aggregative shortages for extended periods is consistent with chronic microeconomic shortages of the kind described in this paper. To verify this a general equilibrium model would have to be constructed. Such a general equilibrium model would have to recognize that many random changes in demand are sectoral in nature. Decentralized pricing presumably responds to these changes by raising prices of the goods in high demand. Centralized pricing presumably responds by more extensive use of rationing. As in the theoretical development of Portes, Quandt, Winter and Yeo (1987), one suspects that a rational planner would not choose to create macroeconomic shortages of the kind investigated by Portes and his collaborators in every state of nature. Occasional macroeconomic shortages, on the other hand, might well arise.<sup>14</sup> These issues remain to be addressed in future research.

FOOTNOTES

1 For closely related papers see Butters (1977) and Carlton (1978). For a different application of the Prescott (1975) model which shows its relevance for productivity movements in the US, see Rotemberg and Summers (1988).

2 In contrast to the disequilibrium literature which treats prices as exogenous or McCallum (1980) who assumes that prices are set so that the market clears on average, price setters maximize profits. In this regard the model is related to the extensive literature (surveyed in Rotemberg (1987)) on monopolistic price setting in the presence of costs of changing prices. The current model differs from those in this literature in assuming perfect competition and in dispensing with the requirement that all units sold in a given period be sold at the same price.

3 According to Walker (1986), resale markets for a variety of items including automobiles are common in the Soviet Union.

4 Price in state 0 equals  $c+v$ . The next highest price is the minimum price above  $c+v$  such that this equation is satisfied and quantity demanded exceeds quantity demanded at  $c+v$ . Subsequent higher prices are computed in the same manner.

5 We saw that there are potentially other states, say  $\sigma$ , such that while  $P(\sigma)$  is charged, price slightly higher than  $P(\sigma)$  are not charged. This means that, while the market clears in state  $\sigma$  it does not clear in slightly higher states since only  $D(P(\sigma), \sigma)$  is sold in these states as well. For  $\sigma$  below  $s^*$  this can hardly be regarded as rationing since customers could, if they wished buy at  $P(s^*)$  and choose not to.

6 This form of rationing is probably of smaller social concern because it doesn't imply that individuals whose marginal utility for

the good exceeds its social marginal cost are left without the good. At worst, it leads to some individuals whose reservation price is below social marginal cost to obtain the good.

7 It is worth noting that this inefficiency is quite general and does not depend on the fact that the good is nonstorable. In the case of storable goods a low realization of demand will lower the price not to its current marginal cost but to the discounted value of what can be obtained for the good in the future. With nonzero discounting, this price will sometimes be below the current cost of production including capacity costs. By contrast, firms with rigid prices will never post a price tag which does not fully cover capacity costs.

8 This ability of planning to achieve the first best with random demand in spite of informational imperfections echos somewhat the result of Lewis and Sappington (1987). They show that a planner who is regulating a monopolist with unknown demand can achieve the first best when marginal cost is nondecreasing. They concentrate on the case where the monopolist can observe the realization of demand before price is set (so all prices respond to demand) but were the planner is much less informed than in my model, he cannot observe even the realization of demand. Since they allow price to respond to demand, there is no rationing in their setting.

9 See Wilczynsky (1982) p. 171. Kornai (1980) p. 555 also informally attributes at least part of the reduction in shortages in the 1970's to increased supply.

10 It is also the form of wage rigidity assumed in Blanchard and Kyotaki (1987).

11 A recursive method for finding this solution goes as follows. Start with a candidate  $k$  so that  $w(0)$  equals  $k + \phi$ . Find the next highest state for which (14) is satisfied and labor demanded at this

wage exceeds  $L(k,0)$ . Continue in this manner finding higher states to which correspond higher wages until there are no higher wages which satisfy (14) and lead to increases in labor demanded. This highest wage is a candidate for  $w(s^*)$ . If  $L(w(s^*),s^*)$  is bigger than  $N$   $k$  must be reduced, if it is smaller it must be increased and if it equals  $N$ , the equilibrium has been found.

12 This appears consistent with Kornai's (1980) assessment that firms in centrally planned economies have a "soft budget constraint" where funds for investment are not given as a simple function of the profitability of earlier investments.

13 One difficulty is that the estimation technique has no role for prices even though the theoretical literature assigns the existence of disequilibrium to inappropriate prices.

14 Kornai (1980) also stresses that shortages can exist at the micro level without aggregating into the kind of shortages sought by Portes and his collaborators.

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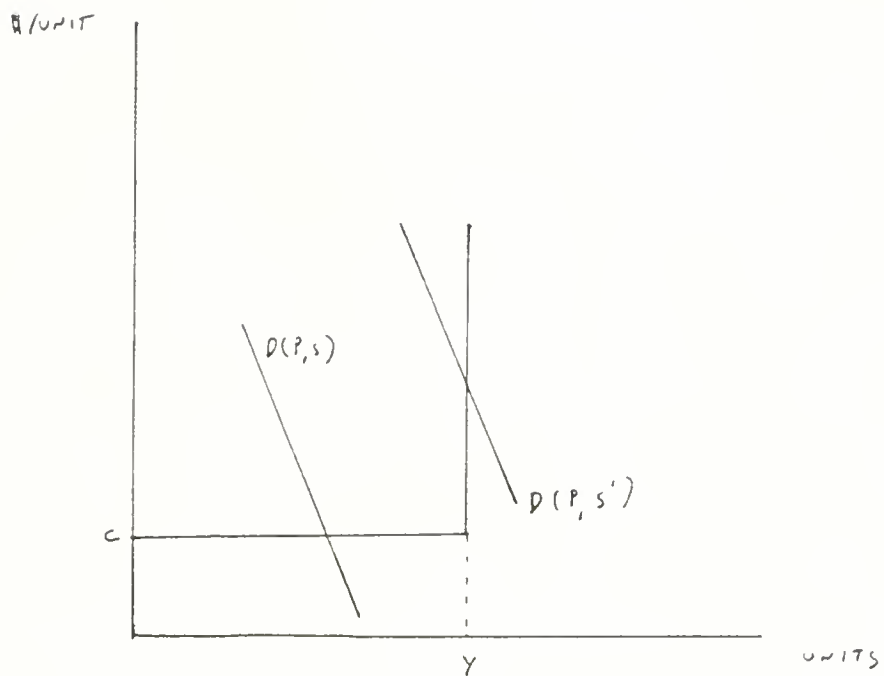


Figure 1

Equilibrium with Flexible Prices

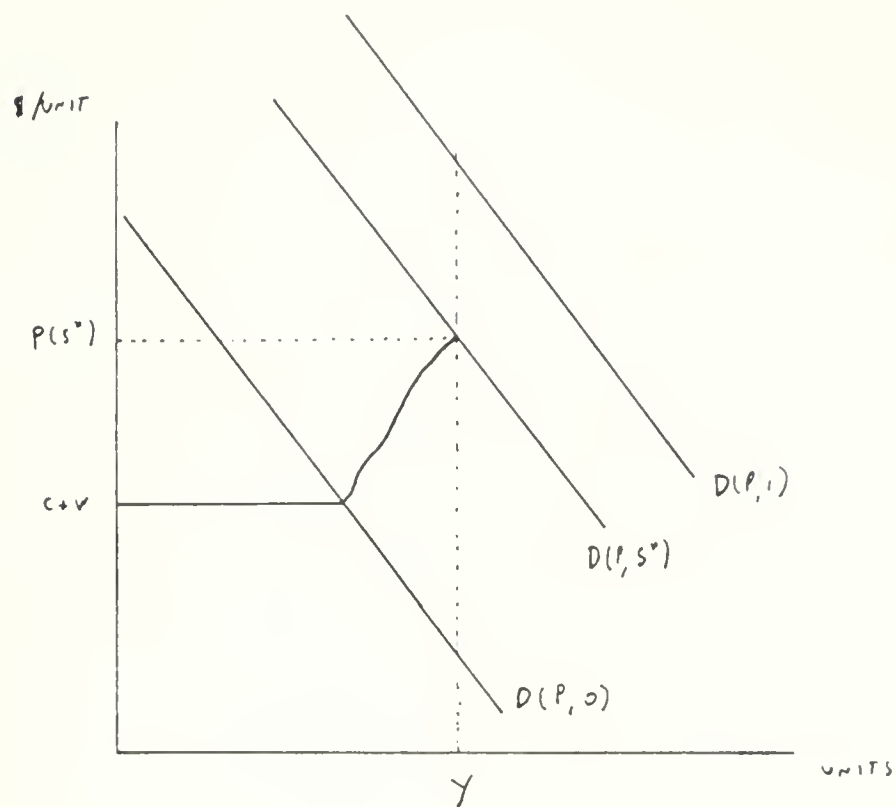


Figure 2

Equilibrium with Rigid Prices

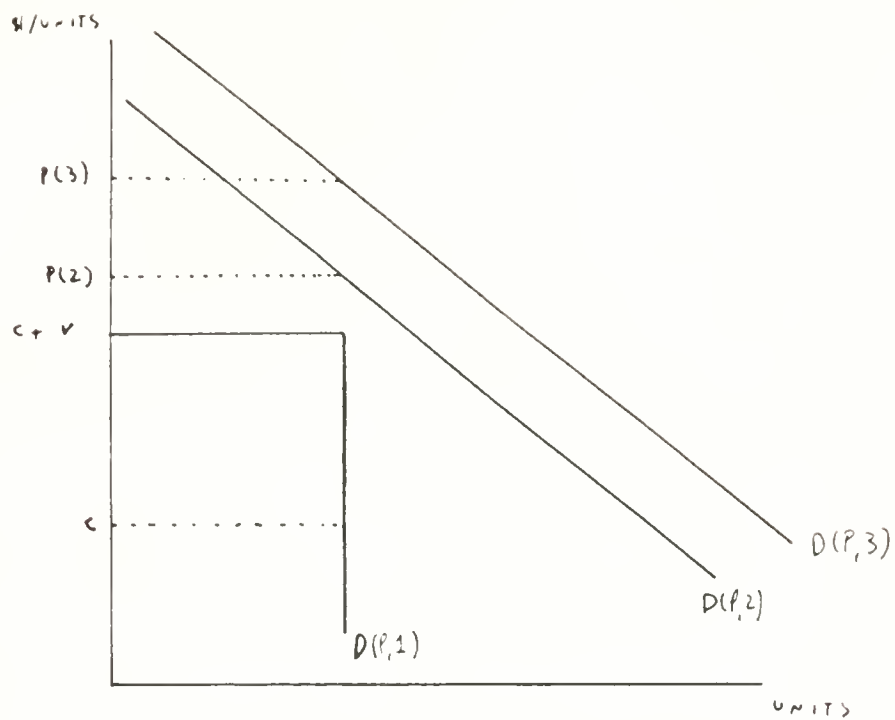


Figure 3

Example : More Rationing with Laissez-Faire

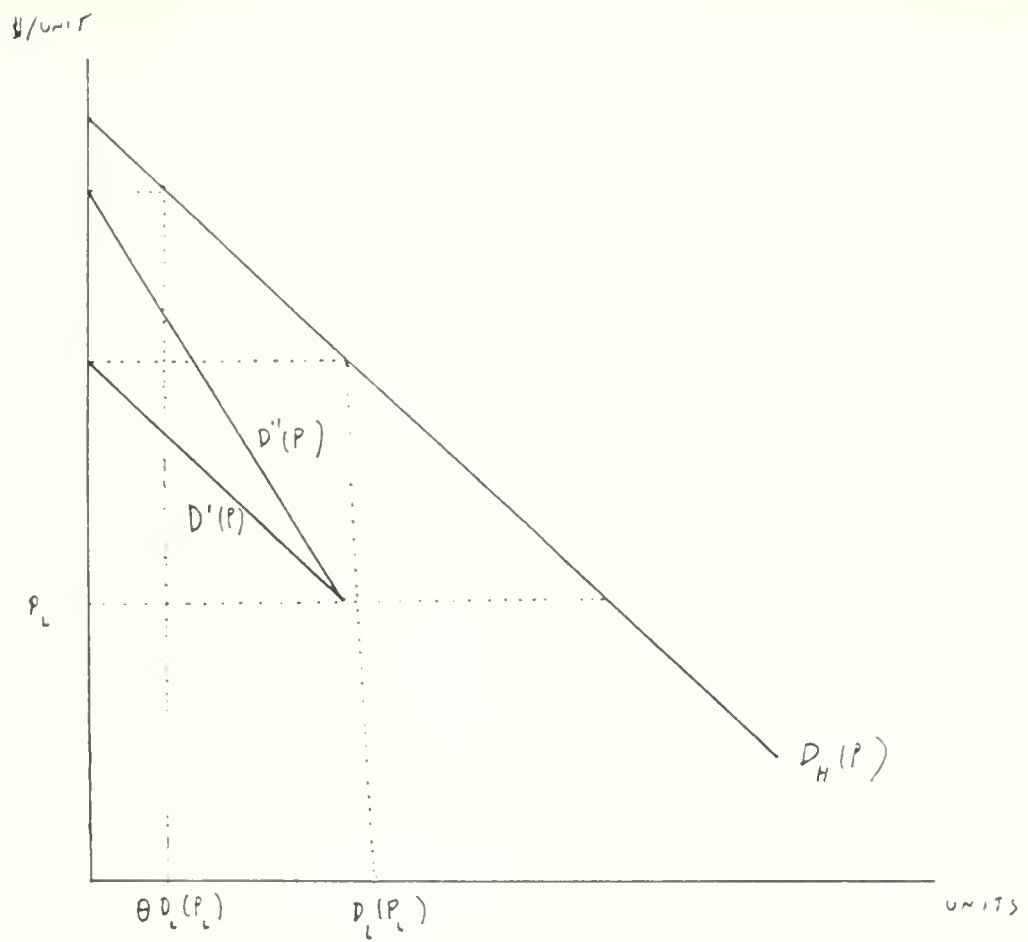


Figure 4

Partially Random Apportionment









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